

Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less.

Marie Curie (1867–1934)

## SURVEILLANCE AND MONITORING

# Toxics Report Improves, but Data Still Limited

One of the gaping holes in the public health tool kit is the lack of comprehensive knowledge about the occurrence and toxic effects of the full spectrum of chemicals emitted by industrial facilities. The Commission for Environmental Cooperation (CEC) has taken a small step toward filling this void by assembling selected basic toxics data for North America with the 10 June 2009 release of its 12th annual report, *Taking Stock: 2005 North American Pollutant Releases and Transfers*. The CEC oversees the North American Agreement on Environmental Cooperation, which supports the environmental provisions of the North American Free Trade Agreement.

*Taking Stock* pulls together the latest data available for all 3 countries on industrial emissions that are tracked under categories such as toxic releases and transfers, criteria air pollutants, fugitive emissions, and greenhouse gases. The report applies a single risk-scoring metric, the toxic equivalency potential (TEP), to make an apples-to-apples comparison of the relative potential threat posed by some of the toxics tracked. And it focuses in particular on North American petroleum industry pollutants, providing what the CEC says is the most complete reporting yet on this industrial sector.

The report draws much of its data from each country's pollutant release and transfer register (PRTR): the Toxics Release Inventory (TRI) of the United States, the National Pollutant Release Inventory (NPRI) of Canada, and the Registro de Emisiones y Transferencia de Contaminantes (RETC) of Mexico. PRTRs examine the media into which pollutants are released—air, water, land, and underground injection—along with transfers of pollutants offsite for recycling, energy recovery, treatment, or other management. Criteria air pollutants are tracked separately, and greenhouse gases are identified through a third data set.

From a very basic perspective, the *Taking Stock* report series is favorably received. "It does help to see all the data together, using all the same units of measurement," says Richard Valentinetti, director of the Air Pollution Control Division within the Vermont Department of Environmental Conservation. He also notes that it's important to monitor and address pollution problems across borders.

But he believes the CEC reports provide limited overall value. "There always are problems comparing data between the three countries," he says. That's because the countries' tracking systems for various pollutants have widely divergent reporting requirements that won't be synchronized anytime soon. It's also due to underlying weaknesses of each individual database. "In the United States, we're still not doing a good job with normal emission inventories," he says.

Even with such limitations—which the CEC acknowledges—the report is use-

ful for identifying and examining large-scale, continent-wide problems, says François Lavallée, manager of Environment Canada's Comprehensive Inventory Compilation and Quality Assurance/Quality Control Section. He anticipates that future reports will become increasingly beneficial since this is just the second year that data for Mexico have been included.

The available data show that the continent's air, water, surface, and subsurface received at least 8,484 billion kg of greenhouse gases, 32 billion kg of criteria air pollutants, and 5.5 billion kg of potentially toxic releases and transfers in 2005. The United States was the primary source, in part because

## Largest Releases/Transfers by Industry in North America

### UNITED STATES: TRI

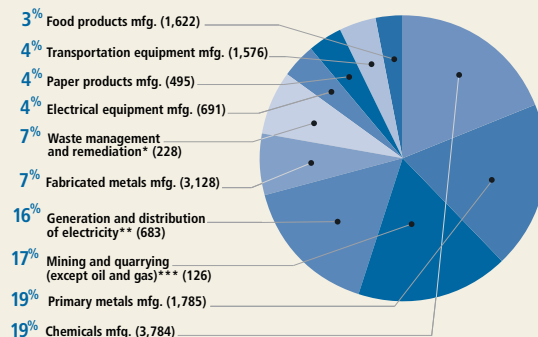
Total reported: 3,189,984,408 kg

In the United States, 14,118 facilities in 10 industrial sectors contributed almost 91% of approximately 3.5 billion kg of releases and transfers reported. The number of facilities reporting is noted in parentheses.

\*Only hazardous waste/solvent recovery facilities must report.

\*\*Only coal- and oil-fired power plants must report.

\*\*\*Each country's PRTR differs in the types of activities required to report under this sector.



### CANADA: NPRI

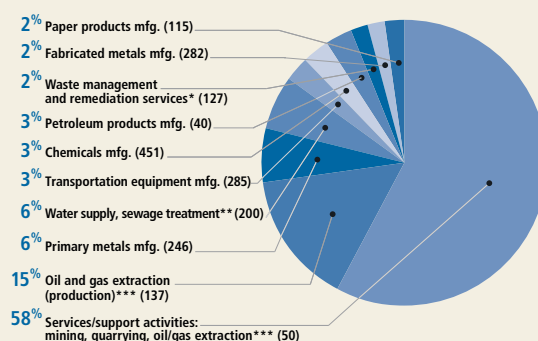
Total reported: 1,948,855,594 kg

In Canada, 1,933 facilities in 10 industrial sectors contributed about 95% of approximately 2 billion kg of releases and transfers reported (criteria air contaminant reporting is not included). The number of facilities reporting is noted in parentheses.

\*In the United States, only hazardous waste/solvent recovery facilities must report.

\*\*Sector is required to report only to the NPRI.

\*\*\*Each country's PRTR differs in the types of activities required to report under this sector.



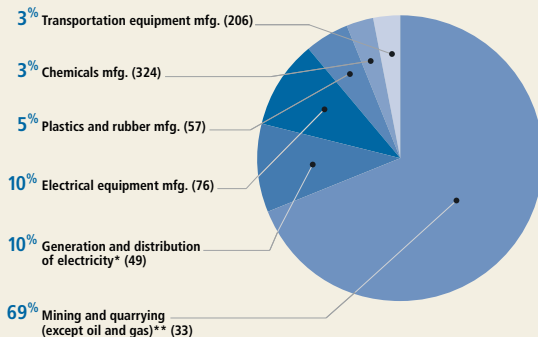
### MEXICO: RETC

Total reported: 62,597,282 kg

In Mexico, 745 facilities in 6 industrial sectors contributed about 96% of approximately 65 million kg of releases and transfers reported (greenhouse gas reporting is not included). The number of facilities reporting is noted in parentheses.

\*In the United States, only coal- and oil-fired power plants must report.

\*\*Each country's PRTR differs in the types of activities required to report under this sector.



Adapted from CEC. 2009. *Taking stock: 2005 North American pollutant releases and transfers*. Montréal: Commission for Environmental Cooperation; p. 24 (Canada), p. 28 (Mexico), p. 32 (United States).

it hosted 82% of the 35,023 industrial facilities required to report at least 1 of the pollutants (of about 889,000 such facilities continent-wide). Canada hosted 12% of the reporting facilities, and Mexico 6%. Because facility-specific data on greenhouse gases are not widely available, the report provides only an overview of these pollutants, which are also produced by non-point sources such as vehicles, agriculture, wild-fire emissions, and commercial and residential properties—sources not subject to PRTR reporting but sometimes included in criteria air pollutant or greenhouse gas inventories.

For substances tracked by the PRTRs, the top overall emitters in Canada were oil and gas extraction, primary metal manufacturing (e.g., smelters), and publicly owned wastewater treatment plants. In Mexico, the leaders were metal mines, electric utilities, and electrical equipment manufacturing. In the United States, chemicals manufacturing, primary metal manufacturing, and mines and quarries led the way. In all 3 countries, large quantities of releases and transfers were reported for the chemicals manufacturing and transportation equipment manufacturing sectors. However, inconsistent reporting requirements—including nomenclature differences—preclude continent-wide comparisons of industries.

TEP calculations were derived through a method developed at the University of California, Berkeley, that expresses a chemical's developmental/reproductive toxicity and carcinogenicity in terms of comparable amounts of toluene and benzene, respectively. The Berkeley method is just one of many such methods, each of which can lead to very different risk findings. TEP calculations in this report apply only to air and water releases and do not provide calculations for other health end points, such as respiratory, cardiovascular, neurologic, or immunologic damage.

Of the substances reported, the CEC determined that mercury and its compounds posed by far the greatest potential health threat, with a TEP for developmental/reproductive risk equivalent to 975.2 billion kg for air releases and 187.5 billion kg for water releases. Next in terms of potential developmental/reproductive toxicity were lead and its compounds, copper and its compounds, arsenic and its compounds, and hydrochloric acid. In addition to its reproductive/developmental effects, air releases of arsenic and its compounds topped the list of carcinogens with a TEP risk equivalent of 947.0 million kg, along with 313.0 million kg for water releases.

Other leading carcinogens included chromium and its compounds, lead and its compounds, glycol ethers, and hydrogen sulfide. There are efforts under way to improve the data used in the report.

However, by grouping metals with their related compounds, some of which may be more or less toxic than the parent metal—as in the case of chromium and arsenic—it is possible the report may miscalculate the risk posed by the total amount emitted. Mexican officials are reviewing health and toxicity data for some pollutants, says Orlando Cabrera-Rivera, the CEC's program manager for air quality and PRTR. That could lead to more substances being added to the 104 currently on Mexico's RETC (in comparison, the NPRI currently lists 323 substances, and the TRI lists 600). Cabrera-Rivera also says that, in addition to facilities under federal jurisdiction, Mexican officials have been adding reporting requirements for some facilities under state jurisdiction. The countries also are cooperating on developing sector profiles in order to establish baselines and thus improve the quality of the data.

Lavallée says Canada has worked at making its PRTR mesh fairly well with that of the United States, but he says it's unlikely his country will add many more substances solely to increase comparability. For instance, he says, many pesticides are listed on the TRI but not on Canada's NPRI because the Canadian pesticide manufacturing industry is only about one-tenth the size of its U.S. counterpart, making emissions from this sector a relatively low Canadian priority. Most changes to the NPRI will be driven by Canada's Chemicals Management Plan and Clean Air Regulatory Agenda. Data on the greenhouse gas categories addressed by the CEC could also improve as reporting requirements in the United States kick in.

Tracking all the substances in this year's report captures less than 0.5% of the 239,000 substances that are regulated or included in inventories worldwide and just 3% of the 30,000 chemicals that are most widely used commercially in Canada and the United States. However, points out Cabrera-Rivera, "While it would be important to include some other pollutants on the PRTR lists, this should be done by prioritizing based on sector pollutant profiles, as well as the potential risk posed by pollutants of concern, since all pollutants are not equal."

Identifying all toxics in the environment, their by-products, and their adverse health effects remains a daunting challenge. But the obstacles to be overcome are disarmingly simple: "Time, resources, and quality of data," Valentineti says.

**Bob Weinhold**, MA, has covered environmental health issues for numerous outlets since 1996. He is a member of the Society of Environmental Journalists.

### Top 30 Pollutants in North America (2005)

Pollutant		Mandatory Reporting			Toxicity	Released (%)	Transferred (%)	Total (kg)
		CA	MX	US		Percentages may not sum to 100% due to rounding		
1	Hydrogen sulfide	•	•			39	61	1,368,487,605
2	Zinc and its compounds	•		•	P	64	36	639,516,966
3	Lead and its compounds	•	•	•	DCP	58	42	453,766,645
4	Copper and its compounds	•		•	P	20	79	422,509,715
5	Nitrate compounds	•		•		72	27	261,638,682
6	Hydrochloric acid	•		•		99	1	259,799,720
7	Methanol	•		•		48	51	235,476,261
8	Manganese and its compounds	•		•		60	41	196,817,633
9	Ammonia	•		•		93	7	168,527,542
10	Sulfuric acid	•		•		54	45	166,764,975
11	Barium and its compounds			•		99	1	111,360,662
12	Toluene	•		•	D	27	74	101,536,968
13	Arsenic and its compounds	•	•	•	DCP	99	0	90,986,426
14	Chromium and its compounds	•	•	•	CP	33	67	87,902,059
15	Nickel and its compounds	•	•	•	DCP	24	76	77,413,728
16	Xylenes	•		•		23	78	76,951,478
17	Ethylene glycol	•		•		5	94	54,799,080
18	Hydrogen fluoride	•		•		95	4	36,115,698
19	Styrene	•	•	•	C	70	30	35,196,460
20	n-Hexane	•		•		52	48	33,592,714
21	Vanadium and its compounds	•		•	C	84	16	30,587,841
22	Dichloromethane	•	•	•	C	9	90	30,234,488
23	Aluminum (fume or dust)	•		•		77	24	27,413,799
24	Phosphorus	•		•		78	22	27,213,543
25	Ethylene	•		•		43	58	21,481,170
26	Glycol ethers			•		47	54	21,239,844
27	n-Butyl alcohol	•		•		42	58	18,289,635
28	Asbestos (friable form)	•	•	•	C	99	0	310,703
29	1,2-Dichloroethane	•	•	•	C	0	100	221,011
30	Formaldehyde	•	•	•	C	100	0	158,162

Note: C = carcinogen; D = developmental/reproductive toxicant; P = persistent bioaccumulative toxicant.

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Adapted from CEC. 2009. Taking stock: 2005 North American pollutant releases and transfers. Montréal: Commission for Environmental Cooperation; p. 41.

## INFECTIOUS DISEASE

## Digging into Seaside Microbial Exposures

Beachgoers enjoying the last days of summer might wish to take note: epidemiologist Chris Heaney of the University of North Carolina at Chapel Hill and colleagues from the U.S. Environmental Protection Agency have found that digging in sand and, to a greater extent, being buried in sand are associated with an increased risk of diarrhea and gastrointestinal illness. “The overall incidence of these cases we’re observing is quite low—less than ten percent,” Heaney says. “But such large numbers of people in the country and the world engage in sand contact activities that, even with a very modest relative risk, you could see substantial disease burden.”

As they report in the 15 July 2009 *American Journal of Epidemiology*, Heaney and colleagues analyzed data gathered from 26,609 participants in 2003–2005 and 2007 as part of a joint effort of the Environmental Protection Agency and the Centers for Disease Control and Prevention. Visitors to 7 freshwater and marine beaches in Michigan, Indiana, Ohio, Mississippi, Alabama, and Rhode Island were interviewed at the beach about their activities there. Then, 10–12 days later, an adult from each family participated in a telephone interview about the incidence of sickness since leaving the beach, including diarrhea alone and a broader group of “gastrointestinal illness” symptoms including diarrhea, vomiting, and nausea.

Of the people who dug in the sand, 6% reported diarrhea, whereas among those who didn’t dig in sand, the incidence of diarrhea was 4%. After accounting for other factors that might cause illness, that amounted to a 20% increase in risk for those exposed, Heaney says. Among people who reported being buried in the sand, 9% reported gastrointestinal illness. Among those who weren’t buried, 7% had gastrointestinal illness. That amounted to a 23% risk increase after accounting for other factors.

Heaney’s study comes even as amendments to the Federal Water Pollution Control Act to strengthen pathogen monitoring in beach

water wind their way through Congress. More than a decade of research has shown that sand at marine and freshwater beaches throughout the United States contains high levels of so-called fecal indicator bacteria. These bacteria, which include *Escherichia coli* and enterococci, are considered markers of sewage contamination and other non-point sources of fecal waste. If found at sufficient levels in water, their presence can result in waterway closures. But current practices don’t take into account their presence in sand.

“[The Heaney study] is the first step showing that we need to look more closely at the risks of exposure to sand at beaches,” says Alexandria Boehm, an environmental engineer at Stanford University. “A year ago, scientists may have thought there are no risks associated with exposure to *Enterococcus* or *E. coli* from beach sand. Then a paper like this comes along, and you have to pause and say, ‘Well, maybe there is a risk.’”

Some studies have suggested that sources of fecal indicator bacteria in sand and water may have little to do with sewage pollution, says Richard Whitman, an ecologist and branch chief at the U.S. Geological Survey Great Lakes Science Center. These and other microbes can come from bird feces, and sand itself makes a good breeding ground for such organisms, studies have shown. “Heaney’s study helps demonstrate that [ensuring beach safety is] far more complex than ‘sewage outfall equals a beachfront closure.’ We need to look at the whole ‘beachshed’ to understand health and pathogen implications,” Whitman says.

Now scientists must explore the possible routes of exposure behind the association between sand and illness. For instance, Heaney is studying whether high levels of fecal indicator bacteria in sand correspond to high incidence of illness. And Whitman reported in volume 7, issue 4 (2009) of the *Journal of Water and Health* that bacteria and viruses from sand transferred readily to hands but that rinsing hands with water removed a large percentage of them.

In the meantime, Heaney’s advice: after playing on the beach, be sure to wash your hands. And don’t swallow the sand!

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## The Beat

by Erin E. Dooley

### Short Nights, Long-Term Health Effect?

In a study published online 30 June 2009 ahead of print in *The Journal of Clinical Endocrinology and Metabolism*, Arlet Nedeltcheva et al. report that repeatedly getting fewer than 6 hr of sleep per night could contribute to factors that can increase the long-term risk of type 2 diabetes. Participants were allowed to eat freely but slept either 5.5 or 8.5 hr each night, with the shorter duration associated with reduced oral glucose tolerance and insulin sensitivity and increased glucose effectiveness. Environmental factors such as noise and light pollution can lead to sleep deprivation.

### E-Cigarettes: Not Quite Healthy

In July 2009 the FDA released its analysis of 19 varieties of tobacco-less “electronic cigarettes.” Produced mainly in China, e-cigarettes are battery-charged devices that

Water vapor “smoke” and a glowing LED tip make e-cigarettes look like the real thing.



heat a nicotine/propylene glycol solution, producing a mist the smoker inhales. Although smokeless e-cigarettes are touted as safer than traditional cigarettes, the FDA found they still deliver detectable levels of known carcinogens and varying levels of nicotine, with 1 e-cigarette delivering twice the nicotine approved by the FDA for smoking cessation aids. Israel, Australia, Canada, and Mexico have banned e-cigarettes.

### A More Granular Look at Food Deserts

Areas where residents have limited access to affordable nutritious food—known as “food deserts”—have been named as a possible factor in the rise in U.S. obesity rates. But in *Access to Affordable and Nutritious Food*, a June 2009 report to Congress, the USDA reports that lack of access to nutritious foods may be a less important factor in obesity than relatively easy access to all other foods. “Many of the stores that carry [fruits and vegetables, whole grains, and low-fat milk] at low prices also carry all the less healthy foods and beverages as well,” write the authors. “Without also changing the dietary behaviors of consumers, interventions aimed at increasing access to healthy foods may not be successful in addressing obesity.”

### World Fisheries Still Afloat

Boris Worm et al. report in the 31 July 2009 issue of *Science* that even though many wild fish populations worldwide are close to collapse—63% of stocks assessed need rebuilding—careful management is beginning



## CHILDREN'S HEALTH

## Sex-Specific Cognitive Effects of Lead

As a neurotoxicant, lead is especially harmful to the developing brain, and early exposures can irreversibly impair children's cognitive and behavioral development. Although a blood lead level of 10  $\mu\text{g}/\text{dL}$  is used as a benchmark for intervention, a growing body of research demonstrates that neurologic effects occur well below this level. Based on research published in *Early Human Development* in August 2009, boys may be even more susceptible than girls to damage related to very low-level lead exposure.

Sex-based susceptibility to low-level lead exposure was previously suspected, but this study is the first to document a statistically significant difference. "Entering into this research, we did not expect to find such a strong gender-based difference in response to very low lead levels, but this hypothesis was confirmed by a long series of analyses," says lead author Wieslaw Jedrychowski, chair of epidemiology and preventive medicine in the College of Medicine at Jagiellonian University in Krakow.

The study population included 457 infants born in Krakow between January 2001 and February 2004. For inclusion in the study, mothers had to be nonsmokers aged 18 to 35 years with no history of chronic diseases such as diabetes or hypertension.

Upon enrolling in the study, expectant mothers completed a detailed questionnaire that covered demographic characteristics, pregnancy dates, and medical and reproductive history. Interviews during pregnancy and after birth provided information about secondhand tobacco smoke exposure during pregnancy and duration of breastfeeding.

At birth a cord blood sample was collected to measure lead concentration, and the Mental Development Index (MDI) of the Bayley Scales of Infant Development—a widely used tool

for assessing mental development in young children—was administered to the women's children at ages 12, 24, and 36 months to assess factors such as problem solving, memory, vocalization, and language. Normal MDI scores are 85 and above, whereas scores below 85 indicate delayed development.

Cord blood lead levels ranged from 0.44 to 4.60  $\mu\text{g}/\text{dL}$ , with a median level of 1.21  $\mu\text{g}/\text{dL}$ . Mean blood lead levels were not significantly different between boys and girls, nor were maternal education (an indicator of socioeconomic status), number of siblings, or prenatal and postnatal secondhand smoke exposure. Among boys, but not girls, cord blood lead levels were significantly associated with a lower MDI score at 36 months after controlling for confounding factors. With the median blood lead level (1.21  $\mu\text{g}/\text{dL}$ ) delineating low and high exposures, high exposure was associated with a 4.5-point deficit in boys' MDI scores.

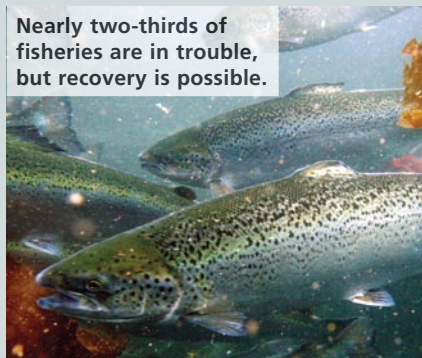
The research was very well done according to Herbert Needleman, a professor of psychiatry and pediatrics at the University of Pittsburgh School of Medicine. "Further," he says, "I think it's important because it concerns what other people have shown: that very small amounts of lead are neurotoxic."

A probable explanation for the observed sex-based difference relates to males generally having fewer receptors for estrogen throughout the central nervous system than females, says Jedrychowski, who with his colleagues wrote, "The consequences of neurotoxicant exposure and the gender differences in the response to toxic exposure can partially depend on the protective effects of estrogen."

Adds Needleman, "Boys are more sensitive to almost all [brain] insults—head injuries and things like that. The basic brain is female; masculinity is 'tacked onto it,' and it's a more fragile apparatus."

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Nearly two-thirds of fisheries are in trouble, but recovery is possible.



to pay off. Half of the 10 regions assessed, including the United States, Iceland, and New Zealand, have cut exploitation rates (the proportion of a total population of fish that are caught), which is a primary factor leading to collapse. The authors add that a global effort is needed to protect against further depletion and collapse, including measures that address the special needs of developing nations, where "most fishers do not have access to alternative sources of food, income, and employment," the authors write.

## Government to Rein In Agricultural Antibiotic Use

In July 2009 the FDA announced its intentions to ban antibiotic use for promoting growth in farm animals and require veterinarian supervision of other agricultural uses of these drugs in order to reduce antibiotic resistance in humans. Two million Americans acquire bacterial infections during hospital stays every year, with 70% of the infections resistant to at least 1 antibiotic. Earlier, the House had introduced phaseout bills banning 7 classes of antibiotics from agricultural use and restricting antibiotics to therapeutic and preventive uses. FDA Deputy Commissioner Joshua Sharfstein testified before the House Committee on Rules that such restrictions will not compromise food safety.

## Styrene Reprieve in California

On 12 August 2009, California Superior Court judge Shelleyanne Chang preliminarily ruled that styrene monomer, a chemical used in the manufacture of items including food packaging and plastics, can be exempted from

listing under the state's Proposition 65 rule. Prop 65 requires that businesses post warnings about products containing known and possible carcinogens. In her ruling, Chang said styrene, which is classified as "possibly carcinogenic" by IARC, is crucial to the transport and sale of the state's \$1.6 billion berry crop and that a Prop 65 listing "could have a devastating effect on that product's use." Chang has 90 days to issue a final ruling on the matter.

A California judge ruled that styrene is crucial to packaging the state's strawberry, blueberry, and raspberry crops.

